From Terabytes of Pixels to Intuitive Brain Networks

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In the midst of a connectomics zeitgeist, microscopy images are collected at an unprecedented rate. The amount of data collected is so overwhelming that it is a challenge for researchers to extract the organizational information of the neural networks embedded within. Developing software that provides researchers intuitive visual representations of their connections of interest would greatly aid them to generate testable hypotheses regarding the functional significance of neural networks -- the impetus for creating the mammalian connectome in the first place. The primary and initial challenge toward developing such a visualization system is the daunting task of thoroughly and reliably quantifying the enormous amount of image data. Achieving this without significant computational aid is intractable. Although algorithms for registering images and automatically reconstructing neuronal processes and axonal pathways for analysis of data exist, they are not efficient for connectivity Big Data given their protracted processing times. Utilizing the data fro the Mouse Connectome Project (MCP) at USC, we developed a beta version of Connection Lens, an innovative informatics pipeline for efficiently and expediently warping, segmenting, and quantifying connectivity data. We have successfully applied Connection Lens toward a limited set of our microscopy image data and we propose to extend its functionality to process our entire archive. Furthermore, leveraging our Connection Lens quantified data we propose to develop a complementary visualization web application. Called Projection Lens, it will render publishable visualizations of user specified connections of interest as connectivity maps, adjacency matrices, network graphs, and flatmaps. Similar to a roadmap, the program will be equipped to show all possible routes between two regions of interest and illustrate how a dysfunctioning node will affect overall information flow within the network. These features will empower researchers to quickly browse, comprehend, and publish fundamental findings regarding functionally distinct neural networks, thereby maximizing the utility of connectomics data nested in terabytes of microscopy scans. The web-based interface of Projection Lens will grant easy access to scientists world-wide. In addition, the code developed for the Connection/Projection Lens (C/PL) framework will be published freely online, and released via an open source license enabling other laboratories to quantify and visualize their data. PUBLIC HEALTH RELEVANCE PUBLIC HEALTH RELEVANCE: As the BRAIN Initiative gains momentum, brain connectivity data is being generated at an unprecedented rate, compiling overwhelming archives of microscopy images embedded with valuable information regarding brain network organization. Our innovative software, Connection/Projection Lens, will reliably and efficiently quantify and visualize these connectivity Big Data, leading to testable hypotheses regarding the functional significance of brain networks. Consequently, this software will facilitate our understanding of how information is processed within specific neural circuits and how this influences cognition and behavior under conditions of health and disease.